456

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RD INSTRUMENTS

FOR RESEARCH AND DEVELOPMENT

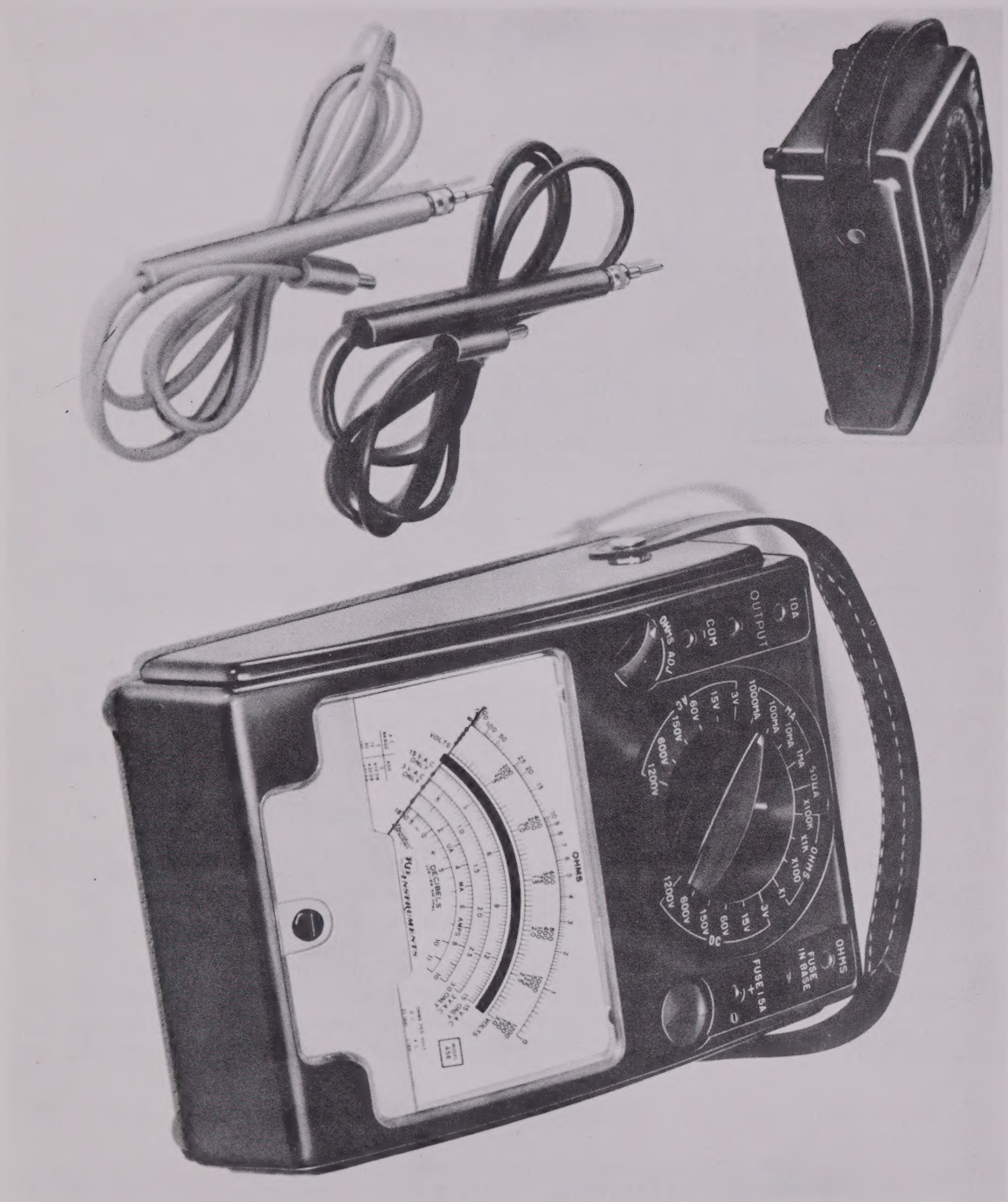
INSTRUCTION MANUAL

for

MODEL 456
VOLT-OHM-MILLIAMMETER

THE HICKOK ELECTRICAL INSTRUMENT COMPANY · 10514 Dupont Avenue, Cleveland 8, Ohio

MODEL 456
VOLT-OHM-MILLIAMMETER



MODEL 456

VOLT-OHM-MILLIAMMETER

STANDARD EIA GUARANTEE

The Hickok Electrical Instrument Company warrants instruments manufactured by it to be free from defective material or factory workmanship and agrees to repair such instruments which, under normal use and service, disclose the defect to be the fault of our manufacturing. Our obligation under this warranty is limited to repairing any instrument or test equipment which proves to be defective, when returned to us transportation prepaid, within 90 days from the date of original purchase, and provided the serial number has been made known to us promptly for our records.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons or service stations in any way so as, in our judgment, to injure their stability or reliability, or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced or removed. Neither does this warranty apply to any of our products which have been connected, installed, or adjusted otherwise than in accordance with the instructions furnished by us. Accessories, including all vacuum tubes not of our manufacture, used with this product are not covered by this warranty.

This warranty is in lieu of all other warranties expressed or implied, and no representative or person is authorized to assume for us any other liability in connection with the sale of our products.

Parts will be made available for a minimum period of five years after the manufacture of this equipment has been discontinued. Parts include all materials, charts, instructions, diagrams, accessories, etc., which have been furnished in the standard model.

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, under warranty or otherwise, the factory must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Upon authorization, this equipment should be forwarded directly to the Hickok factory address, 10636 Leuer Avenue, Cleveland, Ohio, or to a designated service station in your locality. All correspondence pertaining to repairs should be directed to the Hickok office address, 10514 Dupont Avenue, Cleveland 8, Ohio, or to the authorized service station designated.

REGISTRATION CARD

The above guarantee is contingent upon the attached registration card being returned to the factory immediately upon receipt of the equipment.

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
Cleveland, Ohio

TECHNICAL DATA SHEET

Equipment Supplied
(One Complete Unit)

Quan.	Name	Type	Stock No.	Dimension Inches	Wt. Lbs.
1	Volt-Ohm Milliammeter	456	900-	6 x 8 x 3-1/4	3-3/4
1	Test Lead - Gnd (black)		12450-292	48	
1	Test Lead (red)		12450-293	48	
1	Instruction Book		2490-		

TECHNICAL CHARACTERISTICS

1. RANGES

   a. AC VOLTS: 0-3 - 15 - 60 - 150 - 600 - 1200
   b. DC VOLTS: 0-3 - 15 - 50 - 150 - 600 - 1200
   c. OHMS: 0-100 megohms (4 ranges)
   d. MICROAMPERES: 0-50
   e. MILLIAMPERES: 0-1 - 10 - 100 - 1000
   f. AMPERES: 0-10
   g. DB: -18 to +57 in 5 ranges ("0" DB = 1 mw - 600 Ω)

2. SENSITIVITY

   a. AC VOLTS: 1000 ohms per volt
   b. DC VOLTS: 20,000 ohms per volt
   c. METER: 38 microamperes

3. ACCURACY

   a. DC VOLTS and CURRENT: ± 2% of Full Scale
   b. AC VOLTS: ± 3% of Full Scale
   c. FREQUENCY: ± 1 DB to 30 Kc

4. BATTERY COMPLEMENT

Quan.	Name	Type	Size
1	National Carbon #980	Size D *	1.5 volts
1	Eveready #413 "Mini-Max"	Size B *	30 volts

* Not Furnished

5. METER

a. Hickok Model 66W, Style No.
b. Sensitivity: 38 microamperes DC
c. Rectification: 1 copper oxide, full wave, Bridge-type rectifier (external to meter)

6. FUSES

1.5 amp - 6900-22) Bussman Type
0.5 amp - 6900-23) G J U

DESCRIPTION

The Hickok Model 456 RD is a small, compact, stream-lined instrument, built under Hickok high standards of workmanship.

The functions and ranges of this instrument are specifically designed for the industrial and electronic technician.

The indicator is designed to give maximum readability and the slanted meter front allows this instrument to be read while in a flat position, thus minimizing the danger of being knocked over or possibly falling from a workbench.

This instrument features a patented (U.S. Patent No. 2, 671, 874) protection system which protects both the meter and the associated circuits from damage due to accidental overload. The design of this protective system is such that when the Model 456 RD is exposed to damaging overloads, the protective circuit will open the input to this instrument and the input will remain open until the overload has been removed and the protective system reset by pressing the red reset button on the front of the panel. This protective system has been used and proven to be reliable in military and civilian service in European countries. In some cases when the multimeter has been overloaded on extremely low impedance ranges such as the high mils or X1 ohm ranges, fuses in these circuits will open, thus protecting the instrument. These fuses must be replaced before continuing to use the instrument. For location of these fuses see OPERATION, Sections IV and V.

All ranges except the following are protected by the automatic overload system:

10 Amp.
60 and 150 Volts
600 Volts
1200 Volts

The reason the protective system was not used on these ranges is due to the fact that the instrument is inherently safe on overloads in these ranges. If, for example, you are working on the 600 Volt range and accidentally applied 1000 Volts the meter and associated components would take this overload without damage.

On those ranges which are protected by the overload circuit, it is quite possible to apply a voltage or current that would cause the meter to go past full scale and be too small to trigger the protective system. There again, the equipment has been so designed that this type of overload which will not trigger the protective system will not possibly damage the equipment or the meter. The protective system has been so designed that it will respond to overloads either the positive or negative direction, in the case of DC or AC, which, of course, is not polarized.

OPERATION

Be Sure Red Reset Button is Down

1. OVERLOAD PROTECTION

When the Model 456 RD is being subjected to damaging overloads, the protective system will operate, opening the input circuit to this instrument and causing the red reset button to snap up, thus protecting the meter and associated circuits. If the indicator pointer goes beyond full scale but the protective circuit is not activated, then the instrument is not being damaged by the overload.

When the instrument has been overloaded, remove the overload, press the reset button, and if this instrument is on the proper function, rotate the selector switch to a higher range. When subjected to severe overloads on the high mils ranges, the 1.5 amp. fuse in the "+" jack may be blown. To test this fuse, rotate the selector switch to the X100K ohms range, and with the test leads inserted into Jacks 1 and 2 (See Fig. No. 2) short these leads together. If the 1.5 amp fuse is not blown the indicator can be adjusted to zero ohms. In performing this test, make sure the red reset button is down. When the X1 ohms range is subjected to severe overloads, the 0.5 amp fuse located in the base of the case may blow. To check this fuse, remove from its holder and check for continuity by use of the X100 range.

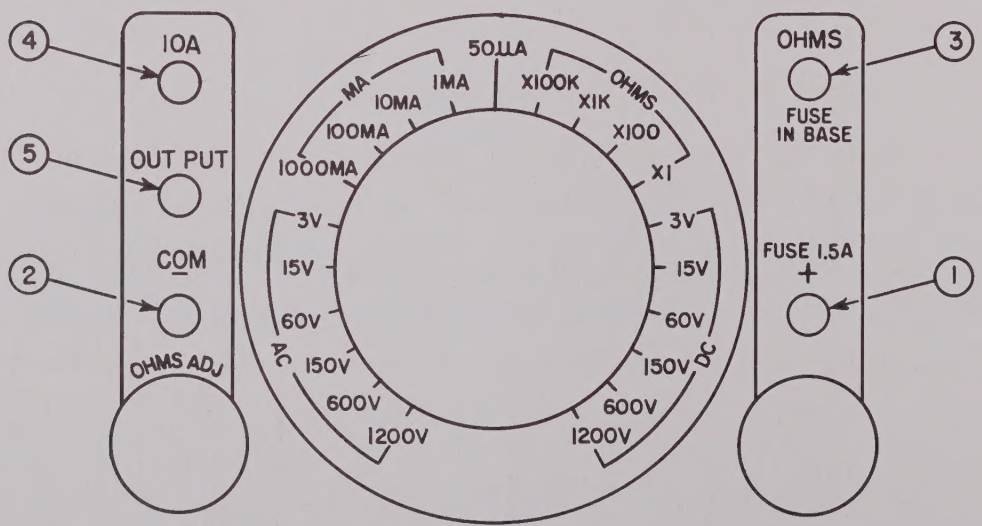


FIG. 2

II. AC VOLTAGE MEASUREMENTS

a. Ranges: 0-3, 15, 60, 150, 600, 1200 volts.

b. Rotate selector switch to the AC function. For greatest accuracy, select a range where the reading will fall in the upper half of the scale.

c. Plug red test lead into the #1 Jack ("+"), and the black test lead into Jack #2 ("Com"). (See Fig. No. 2).

d. Read AC voltage on the appropriate scale and range.

e. If the overload protection circuit operates, see Section I.

III. DC VOLTAGE MEASUREMENTS

a. Ranges: 0-3, 15, 60, 150, 600, 1200 volts.

b. Rotate selector switch to the DC function. For greatest accuracy, select a range where the reading will fall in the upper half of the scale.

c. Plug red test lead into the #1 Jack ("+"), and the black test lead into Jack #2 ("Com"). (See Fig. No. 2).

d. Read DC voltage on the appropriate scale and range.

e. If the overload protection circuit operates see Section I.

IV. OHMS MEASUREMENTS

a. Ranges: X1, X100, X1000, and X100K.

b. Rotate selector switch to the Ohms function.

c. Plug red test lead into the #2 Jack ("Com"), and the black test lead into Jack #3 ("Ohms"). (See Fig. No. 2).

d. Read resistance on the ohms arc and multiply by the setting of the selector switch.

e. The ohmmeter ranges are protected against overload by the protection system. However, the resistance in the X1 range is also protected by a 0.5 amp. fuse located in the base of this instrument and accessible without opening the case. To replace this fuse, unscrew the metal cap and allow fuse to fall out. A spare .5 amp. fuse is located in the dry cell compartment as indicated on the name plate. To replace the dry cells, remove 4 screws securing nameplate to case and snap out defective dry cells. Note markings of dry cells polarity.

V. DC MILS MEASUREMENTS

a. Ranges: 0-1, 10, 100, 1000 mils.

b. Rotate selector switch to DC mils position. For greatest accuracy, select a range where the reading will fall in the upper half of the scale.

c. Plug red test lead into the #1 Jack ("+") and the black test lead into Jack #2 ("Com"). (See Fig. No. 2)

d. Read DC mils on appropriate scale and range.

e. If the instrument has been subjected to overload, see Section I. To replace the 1.5 amp. fuse referred to in Section I, place screwdriver in the slots of the metal sleeve in the "+" jack and turn in a counter-clockwise direction. Remove this metal sleeve and allow fuse to fall from jack.

VI. 50 MICROAMP MEASUREMENTS

a. Rotate the selector switch to the 50 microamp function.

b. Plug red test lead into the #1 Jack ("+"), and the black test lead into Jack #2 ("Com"). (See Fig. No. 2)

c. Read on the 0-10 DC current range and multiply reading by 5.

d. If protection circuit is activated, see Section I.

VII. DC AMPERE MEASUREMENTS

a. Range: 0-10 DC

b. Rotate selector switch to 1000 mils position.

c. Plug red test lead into the #4 Jack, and the black test lead into the #2 Jack (See Fig. No. 2).

d. Read on the DC Current scale.

DECIBEL MEASUREMENTS

a. Range: -18 to +56 db.

b. Rotate selector switch to AC VOLTS position. For greatest accuracy select range where reading will fall in the upper half of the scale.

c. Plug red test lead into the #1 jack ("+"), and the black test lead into Jack #2 ("Com"). (See Figure No. 2).

d. Read on "DB" arc. Note AC range and add "DB" as indicated by the chart in the lower left corner of the scale.

OUTPUT MEASUREMENTS

a. For measuring DB level or AC volts, when a DC voltage is present, plug red test lead into Jack #5. ("OUTPUT") and the black test lead into Jack #2 ("Com"). (See Figure No. 2).

b. Read on appropriate scale.

When making "OUTPUT" measurements, a 0.1 mf condenser is in series with the input. The reactance of this condenser will cause an error on low frequency measurements. However, under normal usage, the range the the frequency being measured is such that this error is negligible.

THEORY

DC MILS

Figure No. 3 is a simplified circuit of the DC mils function of this instrument.

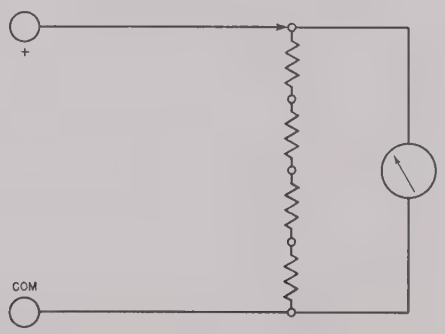


Figure 3. D.C. Mils

Basically, a milliammeter is a meter shunted by resistance. The value of the resistance is such that the total current for a given range is the sum of the current through the meter and the resistance.

To change the range, the value of the parallel resistor is changed by the selector switch.

OHM METER

Fundamentally, an ohm meter is a battery in series with a known resistance which is in a circuit with a meter. See Figure No. 4.

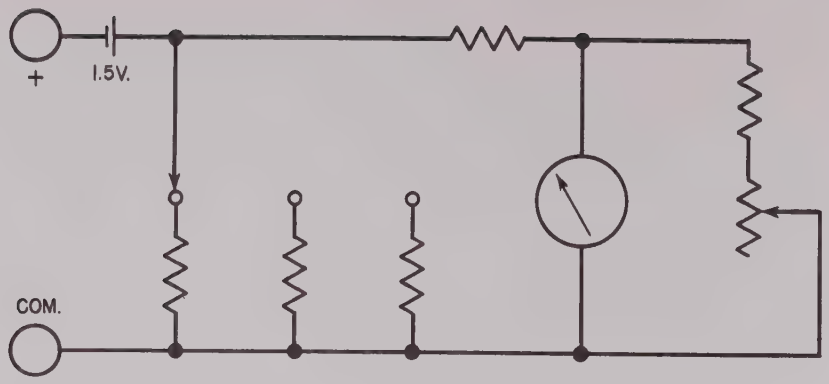


Figure 4. Ohms

When the input is shorted, the full voltage of the battery is developed across the known resistor and the meter is set to indicate zero ohms.

After setting the meter to zero, any unknown resistor placed across the input will divide the voltage across the known resistor in direct proportion to the value of the known and unknown resistors, the meter being calibrated in terms of the value of the unknown resistor.

DC VOLTS

A DC voltmeter is basically a series circuit of a meter and associated resistors (See Figure No. 5). The resistors are chosen so that the current in the series circuit is such that full scale deflection of the meter is obtained when the applied voltage is equal to the full scale reading of the meter.

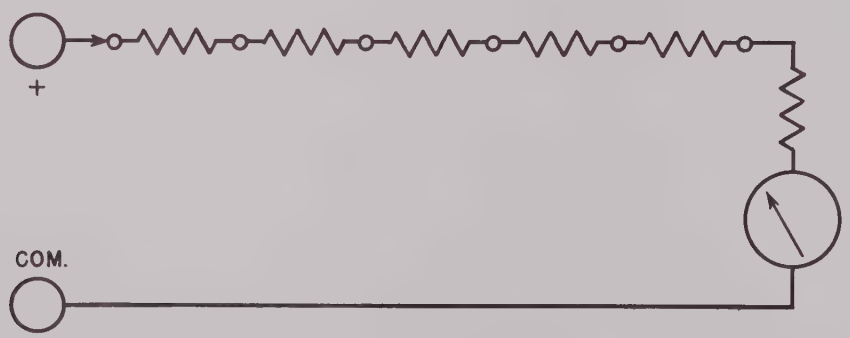


Figure 5. D. C. Volts

To change ranges, the series resistance is changed by the selector switch.

AC VOLTS

As indicated by Figure No. 6, the function of the AC measuring circuit is the same as the DC volts except for the rectification of the AC to provide DC current to operate the meter.

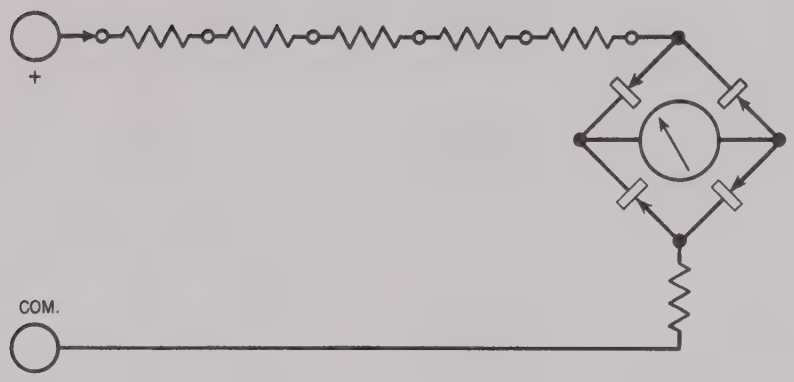


Fig. 6

The indicator in the Model 456RD is a DC movement and the calibration is based on average AC voltage. If AC voltage was impressed across the input without rectification, the average current would be zero and the meter would not respond. However, by rectifying the AC voltage, the current will always flow in one direction and the meter will indicate the average current flow. This deflection is then calibrated in terms of rms voltage.

OUTPUT

This function is for measuring AC voltages when a DC voltage is also present. The basic measuring circuit is identical to the AC volts circuit, Figure 6, except for a blocking condenser which is in series with the OUTPUT jack. This condenser blocks the DC voltage and permits the measurement of the AC voltage.

APPLICATIONS

TELEVISION, RADIO, AND AUDIO SERVICE

The Model 456 RD is ideally suited for this service.

The versatility of this instrument allows for accurate testing of filament voltages across individual tubes, transformers, voltage testing of circuits suspected of being faulty, shorts, continuity tests, open or shorted condensers, fuses, etc.

The extreme range of the ohmmeter circuit - .1 to 100 megohms -is such that this instrument, in some instances, can be used to indicate shorted turns in low resistance coils and also check slightly leaky condensers. Of course, the outstanding feature of this instrument to the service technician is the overload protection to both meter and component parts.

Due to the variety of testing required in the servicing of radio and televisions receivers, AC volts, DC volts, Ohms and MILS, and the different magnitude of voltages being measured, it is highly probable that errors will be made in the range or function when using multimeters. Errors of this type would normally damage the multimeter and deprive the technician of the use of his equipment until repaias could be made. However, the Hickok Model 456 would require only the pressing of a button and occasionally replacing a fuse, when the overload takes place on the low impedance circuits, to immediately restore it to proper operation.

SCHOOLS

The use of the Model 456 RD in schools is a must.

Due to the inherent inexperience of the student, it was previously necessary to use instruments which perform one function, to minimize the change of damage due to misuse of test equipment. However, the Model 456 RD, when improperly used by the student, will protect itself, thus eliminating the need for costly repairs and time lost in returning the equipment for service.

INDUSTRIAL AND FIELD USE

The Model 456 RD is well adapted for use in the industrial field. It can be used in numerous ways such as:

1. Testing of relays and control systems.
2. Testing for open or shorted circuits in conduit.
3. Maintenance of intercommunication systems.

4. Check fusing.

5. Voltage under load and no-load conditions.

6. Shorted and open armatures.

MAINTENANCE

As the Model 456 RD has been built under the high standards of workmanship of a Hickok instrument, no maintenance other than routine replacement of dry cells and fuses should be necessary. Should other maintenance be required, however, it is suggested that the factory be contacted with regard to the nature of the trouble and, if necessary, the instrument be shipped to the factory or an authorized service station in accordance with "Returning Equipment for Repair". A schematic wiring diagram is given to aid in any maintenance work.

Two dry cells, one 1.5 volts and one 30 volts, are used in the source of DC in making ohmmeter measurements. If it is impossible to bring the meter to full scale deflection on the X1, X100, or X1000 ohmmeter ranges, it is probable that the 1.5 volt battery is weak. Likewise, if the meter cannot be brought to full scale on the X100K range, it is probable that the 30 volt battery is weak. To replace these batteries, remove name plate on base of case. The batteries can then be replaced without opening the case. Note the polarity marked near each battery and replace accordingly.

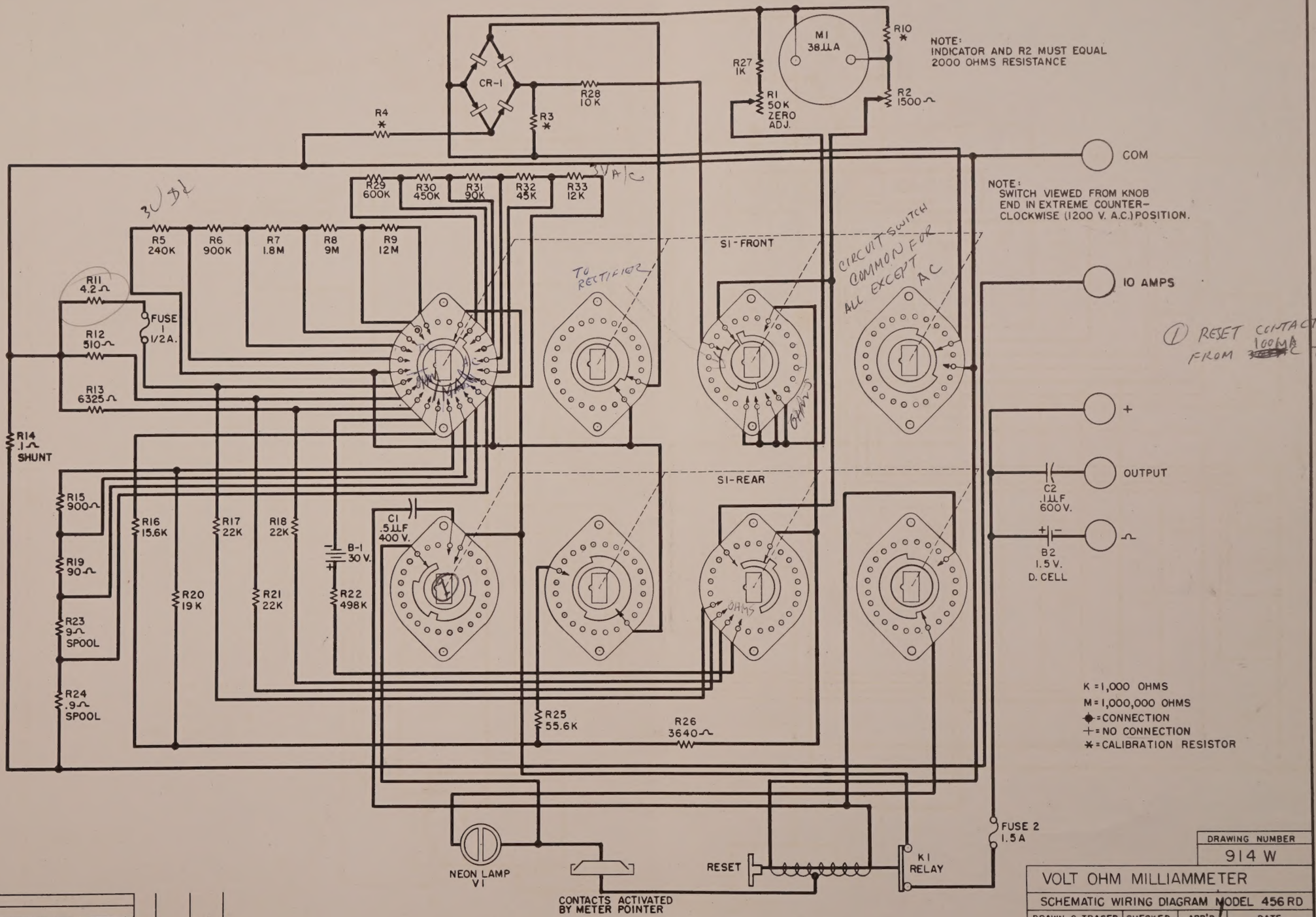
Two spare fuses, 0.5 amp. and 1.5 amps, are also located under the aforementioned nameplate. When replacing fuses, note the current rating and replace in accordance with the value indicated on the front and base of multimeter case.

PARTS LIST FOR MODEL 456RD

Note: There is a minimum billing charge of $1.50 for any one parts order. Prices will be furnished upon request.

Ref. Symbol	Hickok Code No.	Name and Description
B1	2210-17	BATTERY: 30 volt, #413 Eveready "B" Min. Max.
B2	2210-2	BATTERY: 1-1/2 volt, size D, National Carbon
C1	3105-110	CAPACITOR: Metallized .5 mfd., 400V
C2	3105-207	CONDENSER: .1 mfd, 600V
CR-1	18150-42	RECTIFIER: Full wave, 5 MA, Copper Oxide
* F1	6900-23	FUSE: 0.5 amp. Bussman Type GJU, Resistance .9Ω
* F2	6900-22	FUSE: 1.5 amp. Bussman Type GJU.
M1	660-134	METER: 38μa approx. 1300Ω
R1	16925-258	POTENTIOMETER: 50,000 ohms, carbon, linear
R2	16925-266	POTENTIOMETER: 1500 ohms, Wire wound
R5	18537-149	RESISTOR: 240K ohms, 1/2%, 1/2 watt
R6	18537-150	RESISTOR: 900K ohms, 1/2%, 1/2 watt
R7	18538-7	RESISTOR: 1.8 megohms, 1/2%, 1/2 watt
R8	18539-35	RESISTOR: 9 megohms, 1/2%, 1 watt
R9	18540-11	RESISTOR: 12 megohms, 1/2%, 2 watt
R11	18550-172	RESISTOR: 4.2 ohms
R12	18540-12	RESISTOR: 510 ohms, 1/2%, 2 watt
R13	18537-160	RESISTOR: 6.325K ohms, 1/2%, 1/2 watt
R14	19210-79	SHUNT: 1Ω, 1%
R15	18537-161	RESISTOR: 900 ohms, 1/2%, 1/2 watt
R16	18537-159	RESISTOR: 15.6K ohms, 1/2%, 1/2 watt
R17	18413-221	RESISTOR: 22,000 ohms, 5%, 1/2 watt
R18	18413-221	RESISTOR: Same as R17
R19	18550-171	RESISTOR: 90 ohms, 1/2%, 1 watt
R20	18537-151	RESISTOR: 19,000 ohms, 1/2%, 1/2 watt
R21	18413-221	RESISTOR: Same as R17
R22	18540-13	RESISTOR: 498K ohms, 1/2%, 2 watt
R23	18670-105	RESISTOR: spool, 9 ohms, 1%
R24	18670-101	RESISTOR: .9 ohms, 1%
R25	18536-153	RESISTOR: 55.6K ohms, 1/2%, 1/2 watt
R26	18537-155	RESISTOR: 3640 ohms, 1/2%, 1/2 watt
R27	18412-101	RESISTOR: 1000 ohms, 5%, 1/2 watt
R28	18413-101	RESISTOR: 10KΩ, ±5%, 1/2 watt
R29	18537-152	RESISTOR: 600,000 ohms, 1/2%, 1/2 watt
R30	18537-154	RESISTOR: 450K ohms, 1/2%, 1/2 watt
R31	18537-156	RESISTOR: 90K ohms, 1/2%, 1/2 watt
R32	18537-158	RESISTOR: 45K ohms, 1/2%, 1/2 watt
R33	18537-157	RESISTOR: 12K ohms, 1/2%, 1/2 watt

ALT	DRAWING NUMBER
	914 W



ALTERATION	BY	APP'D	DATE

DRAWING NUMBER
914 W

VOLT OHM MILLIAMMETER

SCHEMATIC WIRING DIAGRAM MODEL 456 RD

DRAWN & TRACED	CHECKED	APP'D	DATE
RB	PJK		4-22-59

THE HICKOK ELECTRICAL INSTRUMENT CO.
CLEVELAND, OHIO